

## **Ecosystems**

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### **SYLLABUS**

#### **Ecosystem**

Ecosystem : Structure & Function, Productivity, Decomposition, Energy Flow, Ecological Pyramids, Ecological Succession, Nutrient Cycling, Ecosystem Services, Importance of Ecosystem

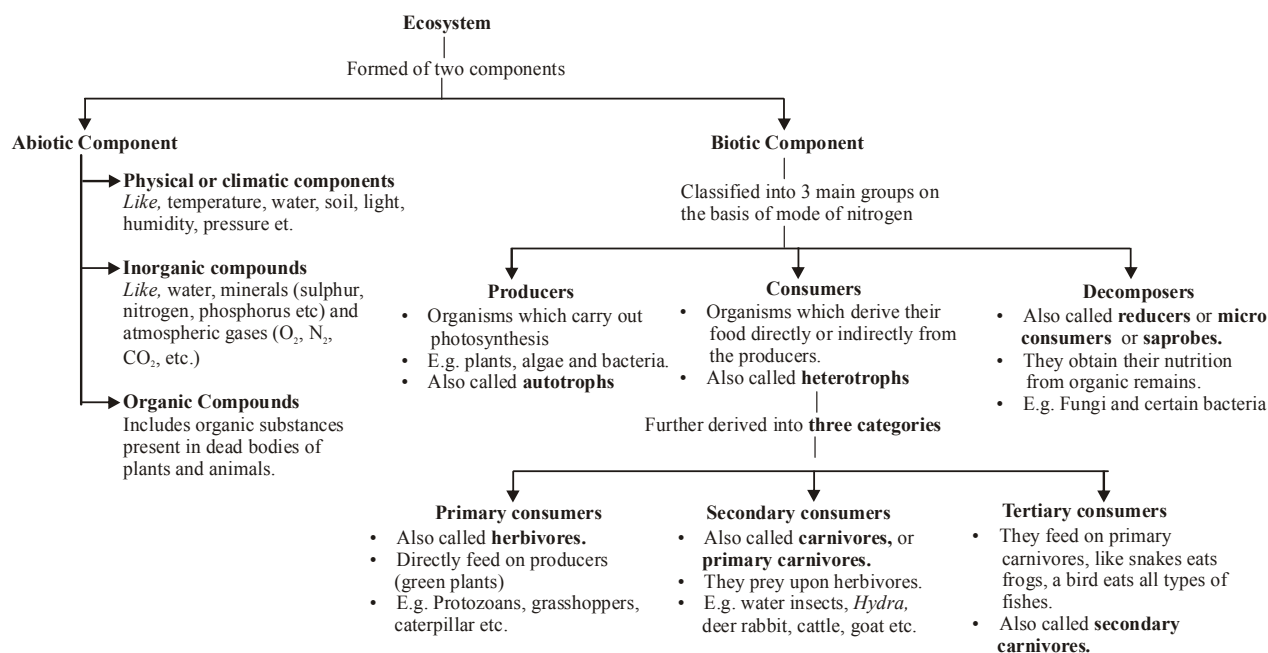
Name : \_\_\_\_\_

Contact No. \_\_\_\_\_

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- The term 'ecosystem' was proposed by a British ecologist **A.G. Tansley (1953)**. It represents the basic fundamental, functional unit of ecology which comprises of the biotic community together with its abiotic (non-living) environment.
- Ecosystem is the functional unit of nature where living organisms interact with each other and with their environment.
- Ecosystems can be recognized as self regulating and self sustaining units of landscapes that may be **terrestrial** or **aquatic**. Forests, grasslands and deserts are **example of terrestrial ecosystems**. The **aquatic ecosystems** can be either fresh water (ponds, lakes, streams) or salt water (marine estuaries) type.
- Ecosystem may be **natural** (forest, sea), if developed under natural conditions or **artificial** (garden, aquarium, agriculture) it created by man.
- Ecosystem is normally an **open system** because there is a continuous and variable entry and loss of energy and materials. Ecosystem is known by different terms i.e., biogeocoenosis or geobiocoenosis or microcosm or ecosom or biosystem etc., the whole earth can be called biosphere or ecosphere.
- Ecosystem is composed of a variety of abiotic (non-living) and biotic (living organisms) components that function in an interrelated fashion.



**Flow chart : Components of Ecosystem**

## ECOSYSTEM – STRUCTURE AND FUNCTION

- Ecosystem is self sustained functional units.
- The structure of an ecosystem can be expressed by the following terms –
  - **Species compositor** : Plant and animal species found in an ecosystem.
  - **Stratification** : Vertical layers of plants.
  - **Standing crop** : Amount of biomass
  - **Standing state** : Amount of inorganic substances.
- **Species composition**
  - It differs from one ecosystem to another depending upon geography, topography and climate.
  - Each ecosystem has a biotic community composed of particular grouping of species.

- Maximum species composition occurs in tropical rainforests and coral reefs. Minimum occurs in deserts and arctic regions.

#### ■ **Stratifications**

- Stratification is the occurrence of vertical zonation in the ecosystem & indicates the presence of favourable environmental conditions, for e.g., trees occupy top vertical strata or layer of a forest, shrubs the second & herbs & grasses occupy the bottom layers.
- Stratification helps in accommodation of large number & types of plants in the same area. It also provide a number of microhabitat & niches for various types of animals.
- It is absent or poor where environmental conditions are unfavourable, e.g. desert ecosystems have very few trees & shrubs.

#### ■ **Standing crop**

- Standing crop is the amount of living biomass in an ecosystem. It indicates the productivity & luxuriance of growth.
- It is expressed in the form of number or biomass of organisms per unit area.
- A terrestrial ecosystem with high standing crop possesses a forest while the one with low standing crop occurs in grassland followed by the arid ecosystem.

#### ■ **Standing state**

- The amount of nutrients, e.g., nitrogen, phosphorus & calcium present the soil at any given time is known as **standing state**.
- The proper functioning of an ecosystem takes place through the following processes :
  - Productivity
  - Decomposition
  - Relationship of producers and consumers
  - Flow of energy through different trophic levels, and
  - Cycling of nutrients

### **PRODUCTIVITY**

- **Productivity** refers to the rate of biomass production i.e. the rate at which sunlight is captured by producers for the synthesis of energy rich organic compounds.
- It is of **two-types** – primary productivity and secondary productivity.
- **Primary productivity** is the amount of biomass produced per unit area over a time period by plants during photosynthesis.
- It is expressed in terms of weight ( $g^{-2}$ ) or energy ( $kcal\ m^{-2}$ ). It is of **two types** : GPP and NPP.
- **Gross primary productivity (GPP)** – It is the rate of production of biomass or accumulation of energy by green plants per unit area per unit time. GPP depends on the chlorophyll content.
- **Net primary productivity (NPP)** – It is the amount of biomass which has been stored by green plants.
- The net primary productivity results in the accumulation of plant biomass, which serves as the food of herbivores & decomposers.
- NPP is equal to the rate of organic matter created by photosynthesis minus the rate of respiration and other losses.  
**Net primary productivity = Gross primary productivity – Respiration losses. (or  $GPP - R = NPP$ )**
- **Secondary productivity** is the amount of biomass synthesized by consumers per unit area per unit time.

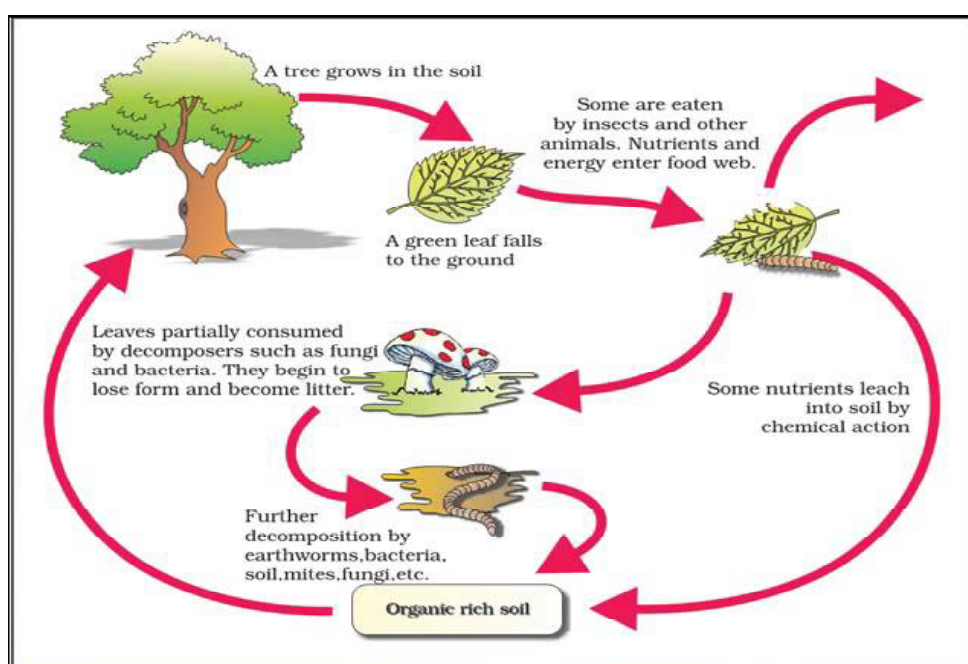
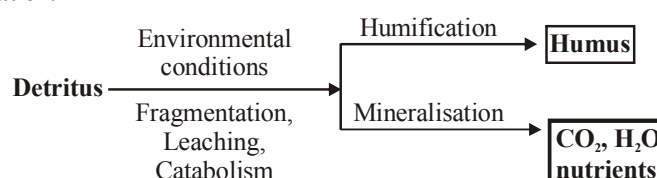
- Consumers tend to utilize already produced food materials in their respiration and also convert the food matter to different tissues by an overall process. So secondary productivity is not divided into 'gross' and 'net' amounts.
- The annual net primary productivity of the whole biosphere is approximately 170 billion tons of organic matter.

## DECOMPOSITION

- **Decomposition** is the breakdown of complex organic compounds of dead bodies of plants and animals into simpler inorganic compounds like  $\text{CO}_2$ , water & various nutrients.
- The organisms carrying out decomposition are called **decomposers**.
- Decomposers include **micro-organisms** (bacteria and fungi), **detritivores** (earthworm) and some **parasites**.

### Process of Decomposition

- Decomposition is physical as well as chemical in nature and consists of the following processes :
  - **Fragmentation** : It is the formation of smaller pieces of dead organic matter or detritus by detritivores. Due to fragmentation, the surface area of detritus particles is greatly increased.
  - **Catabolism** : Chemical conversion of detritus into simpler inorganic substances with the help of bacterial and fungal enzymes is called catabolism.
  - **Leaching** : Water soluble substances (formed as result of decomposition) are leached to deeper layers of soil.
  - **Humification** : If decomposition leads to the formation of colloidal organic matter (humus), the process is called **humification**. Humus is highly resistant to microbial action and undergoes extremely slow decomposition. It serves as a reservoir of nutrients.
  - **Mineralisation** : Formation of simpler inorganic substances (like  $\text{CO}_2$ , water and minerals) is termed **mineralisation**.



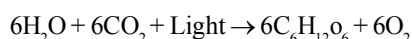
**Fig. :** Diagrammatic representation of decomposition cycle in a terrestrial ecosystem

### Factors Affecting Decomposition

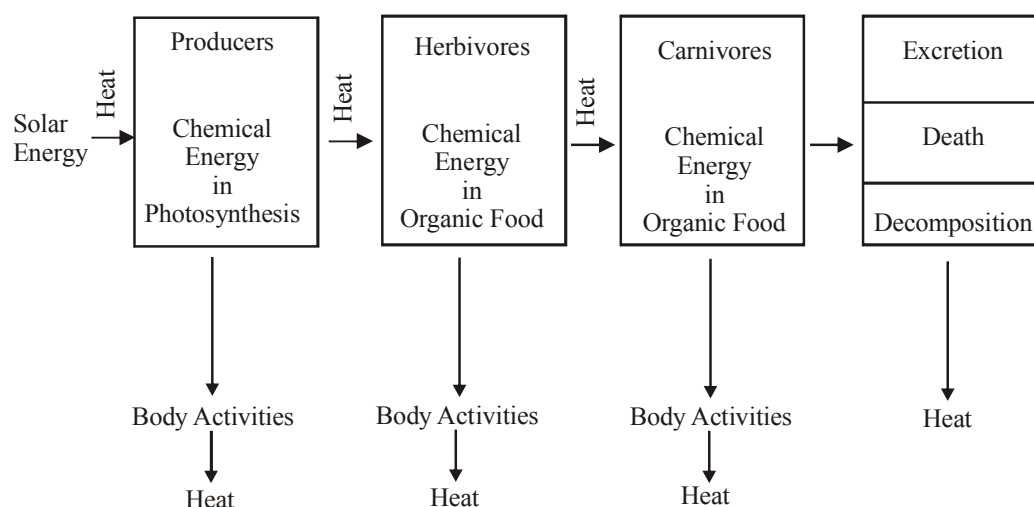
- The rate of decomposition is dependent on many factors like chemical nature, temperature, availability of oxygen, moisture, etc.
- **Chemical nature of detritus :** Decomposition of detritus is slow if contains chitin, tannins and cellulose. It is rapid if detritus processes more of nitrogenous compounds like proteins, nucleic acids and reserve carbohydrates.
- **Temperature :** At a temperature more than 25°C, decomposers are very active in soils having good moisture and aeration. In humid tropical regions, it does not take more than 3-4 months for complete decomposition of detritus. However, under low temperature conditions (>10°C) of soils, the rate of decomposition is very slow even if moisture and aeration are optimum. Because of it, complete decomposition of detritus may take several years or even decades.
- **Moisture :** An optimum moisture helps in quicker decomposition. Reduction in moisture reduces the rate of decomposition as in areas of prolonged dryness like tropical deserts where otherwise the temperature is quite high. Excessive moisture also impedes decomposition. It may promote pearl formation.
- **Aeration :** It is required for the activity of decomposers and detritivores. A reduced aeration will slow down the process of decomposition.
- **Soil pH :** Detritivores are fewer in acidic soils. Microbial activity is also low in such soils. Detritivores are abundant in neutral and slightly alkaline soils while decomposers microbes are rich in neutral and slightly acidic soil.

### ENERGY FLOW

- Energy is the ability to do work. The main source of energy for an ecosystem is the radiant energy or light energy derived from the sun. 50% of the total solar radiation that falls on earth is **photosynthetically active radiation (PAR)**. The amount of solar radiation reaching the surface of the earth is 2 cal/sq.cm./min. It is more or less constant and is called **solar constant or solar flux**. About 95 to 99% of the energy is lost by reflection. The light energy is converted into chemical energy in the form of sugar by photosynthesis.

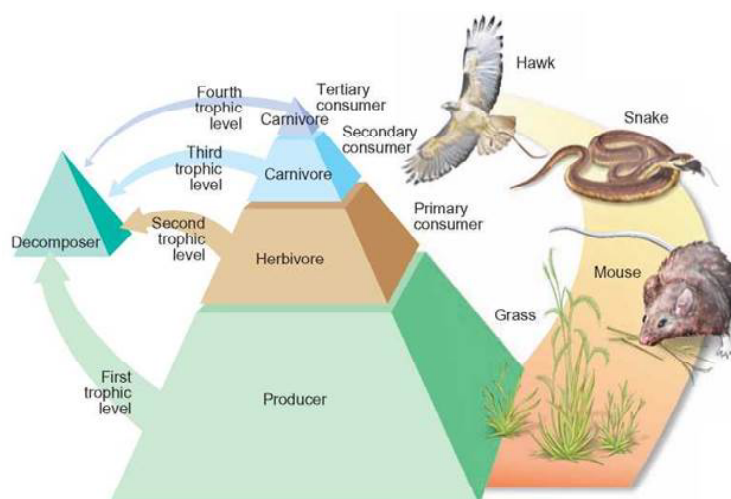


- The rate of energy transfer between elements of an ecological system is called **energy flow**. The **flow of energy is unidirectional** in the ecosystem.



**Fig. : Energy Flow in Ecosystem**

- Plants utilize 2–10% of PAR in photosynthesis.
- The energy formed by the green plants (producers) then flow through different trophic levels of ecosystem i.e., primary, secondary and tertiary consumers.
- **Producers** include green plants which are capable of manufacturing their own food. These are able to fix the energy obtained from the sun. Producers are autotrophic, generally chlorophyll bearing organisms.
- **Consumers (phagotrophs)** cannot make their own food but are directly or indirectly dependent on producers for obtaining food. Consumers may be :
  - Primary consumers or **herbivores**.
  - Secondary consumers or **primary carnivores**.
  - Tertiary consumers or **secondary carnivores**.
- **Primary consumers** obtain their food by directly feeding on producers (plants), **secondary consumers** from primary consumers (herbivores) and **tertiary consumers** from secondary consumers.
- The conversion of radiant energy of sun into chemical energy and its subsequent transfer to other organisms occurs in accordance with the laws of thermodynamics.
- **First law of thermodynamics** states that energy is neither created nor destroyed but can be transferred from one component to another. E.g. sunlight energy can be transferred into energy of food & heat.
- **Second law of thermodynamics** : At each step of energy transformation, there occurs dissipation of energy and increase in disorderliness.
- **Trophic structures** of ecosystem is a type of producer-consumer arrangements in which each food level is called **trophic levels**.
- All trophic levels in an ecosystem are connected by transfer of food or energy.
- Two aspects with respect to energy flow to ecosystem are important. *First*, the energy flows unidirectional i.e. from producers through herbivores to carnivores; it cannot be transferred in the reverse direction. *Second*, the amount of energy flow decreases with successive trophic levels. Producers capture only a small fraction of solar energy (1–5 percent to total solar radiation), and the bulk of initialized energy is dissipated mostly as heat. Part of the energy captured in gross production of producers is used for the maintenance of their standing crop (respiration) and for providing food to herbivores. The unutilized net primary production is ultimately converted to detritus, which serve as energy source to decomposers. Thus, energy actually used by the herbivore trophic levels is only a small fraction of energy captured at the producers levels.



**Fig. : Trophic level pyramid**

- A large amount of energy is lost at each trophic level. It is estimated that 90% of the energy is lost when it is transferred from one trophic level to another. Hence, the amount of energy available decreases from step to step. Only about 10% of the biomass is transferred from one trophic level to the next one in a food chain. And only about 10% chemical energy is retained at each trophic level. When the food chain is short, the final consumers may get a large amount of energy. But when the food chain is long, the final consumer may get a lesser amount of energy.

### Food chain

- The ecosystems is characterized by the energy flow and the circulation of material through its members. The different organisms of an ecosystem are linked together by their nutritional requirements. Individual related in this manner constitute a food chain.
- **Food chain** is an order or sequence of different organisms which are arranged in a way that the food is passed from one type of organisms to the other organisms such that the organisms of one order or trophic level are the food of the organisms of next order.

- **Types of food chains :** The food chains are of two types, namely :

- (i) **Grazing food chain :** This food chain starts from plants, goes through herbivores and ends in carnivores.

Plant → Herbivores → Primary Carnivores → Sec. Carnivores

This type of food chain depends on the autotrophs which capture the energy from solar radiation.

A few chains are given below :

Grass ® Grasshopper ® Lizard ® Hawk

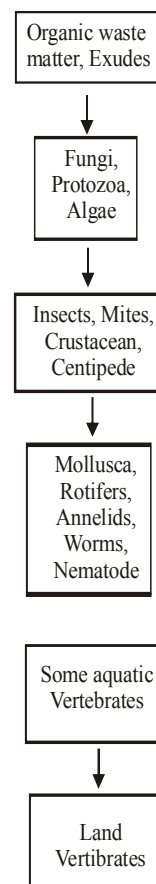
Grass ® Mouse ® Snake ® Hawk

Photoplankton ® Zooplankton ® Fish ® Snake

The grazing food chain is further divided into two types, namely : (a) Predator (b) Parasitic

- (ii) **Detritus food chain :** It start from dead organic matter and ends in inorganic compounds. There are certain groups of organisms which feed exclusively on the dead bodies of animals and plants. These organisms are called **detritivores**. The detritivores include algae, bacteria, fungi, protozoans, insects, millipedes, centipedes, crustaceans, mussels, clams, annelid worms, nematodes, ducks, etc.

### Detritus food chains is



**Table : Difference between Grazing and Detritus food chains**

S.No.	Grazing food chain	Detritus food chain
1	The chain begins with producers as the first trophic level.	The chain begins with detritivores and decomposers as the first trophic level.
2	Energy for the food comes from sun.	Energy for the food comes from organic remains or detritus.
3	Food chain adds energy into the ecosystem.	It retrieves food energy from detritus and prevents its wastage.
4	The food chain binds up inorganic nutrients.	The food chain helps in releasing inorganic nutrients to the cycling pool.
5	It account for less energy flow because most organisms die without having been eaten.	Detritus food chain can account for more energy flow.
6	Cattle grazing in grassland, deer browsing in forest and insects feeding on crops and trees are most common biotic constituents of grazing food chain.	In the forest, an example of detritus food chain is : detritus → Soil Bacteria → Earthworms

## Food Web

- **Food web** refers to a group of inter-related food chains in a particular community. Under natural conditions, the linear arrangement of food chain hardly occurs & these remain indeed inter-connected with each other through different types of organisms at different trophic level.
- Simple food chains are very rare in nature. This is because each organisms may obtain food from more than one trophic level. In other words, one organism forms food for more than one organisms of the higher trophic level.
- Food webs are very important in maintaining equilibrium (homeostasis) of ecosystem.

**Example :** In a grassland ecosystem

- Grass → Grasshopper → Hawk
  - Grass → Grasshopper → Lizard → Hawk
  - Grass → Rabbit → Hawk
  - Grass → Mouse → Hawk
  - Grass → Mouse → Snake → Hawk
- **Significance of food web :** Food webs are very important in maintaining the stability of an ecosystem. For example, the deleterious growth of grasses is controlled by the herbivores, when one type of herbivores increase in number and control the vegetation.
- Similarly, when one type of herbivores animal becomes extinct, the carnivore predating on this type may eat another type of herbivore.

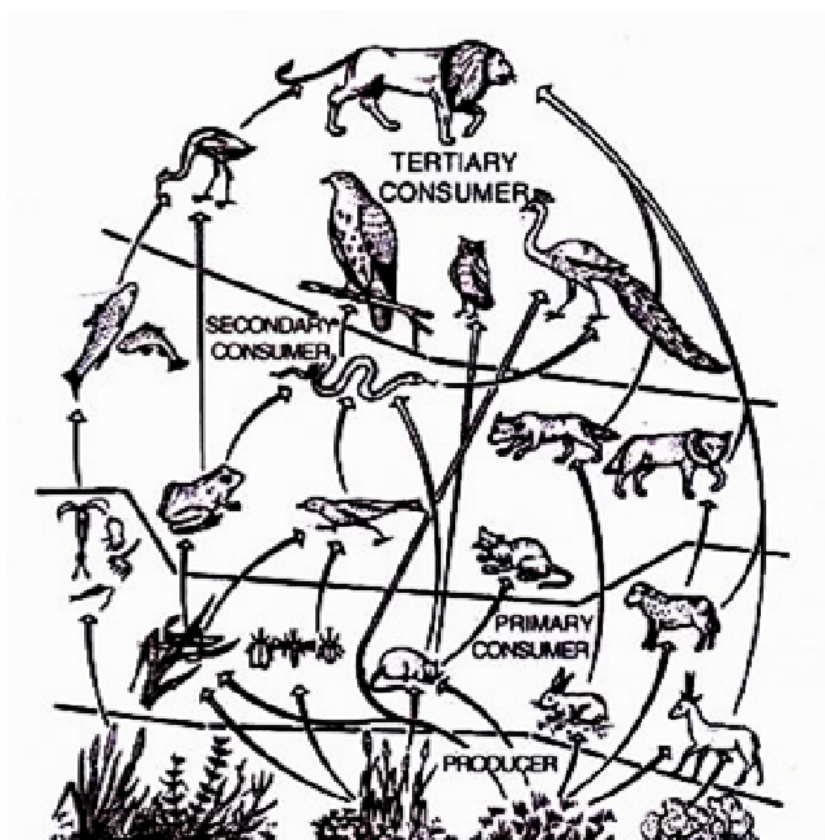


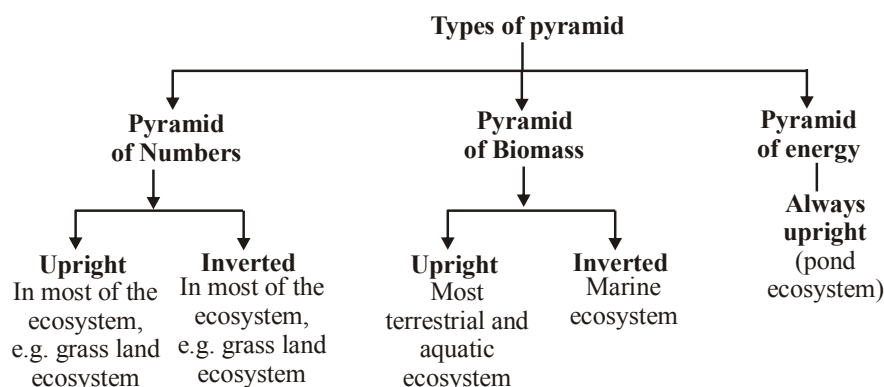
Fig. : Food web in a grassland ecosystem

**Table : Difference between Food chain and Food web**

S.No.	Food chain	Food web
1	It is a straight single pathway through, which food energy travels in an ecosystem.	It consists of a number of food chain through which food energy passes in the ecosystem.
2	Members of higher trophic level fed upon a single type of organisms of lower trophic level.	Members of higher trophic level can feed as a number of alternative organisms of the lower trophic level.
3	Presence of separate and isolated food chains adds to the instability of the ecosystem.	Presence of food web increases the stability of the ecosystem.
4	It does not add to the adaptability and competitiveness of the organisms.	Food web increases adaptability and competitiveness of the organisms.

## ECOLOGICAL PYRAMIDS

- The number, biomass and energy of organisms gradually decreases from the producer level to the consumer level. The number of individuals present or amount of biomass synthesized or amount of energy stored at successive trophic levels in an ecosystem can be graphically represented in the form of pyramids. These are called **ecological or Eltonian pyramids**. The use of ecological pyramid was first described by **Charles Elton in 1927**.
- In the ecological pyramid, the producer forms the base and the final consumer occupies the apex.
- Three ecological pyramids which are studied are – **pyramid of number, pyramid of biomass and pyramid of energy**.



**Flow chart : Types of Pyramid**

### Pyramid of Number

- Pyramid of number is **usually upright**.
- It is a graphical representation of numerical strength of various populations in different trophic levels per unit area of an ecosystem with producer forming base, intermediate levels forming intermediate tiers & apex formed by top carnivores.
- In an ecosystem, number of individuals is generally maximum at the producer level. The number of herbivores is lesser than the producers. Similarly, the number of carnivores is lesser than the herbivores. Number of producers per unit area is more in pond ecosystem than grassland ecosystem. In forest ecosystem the pyramid of number is intermediate. Here the number of primary consumers is more than producers as well as top consumers.

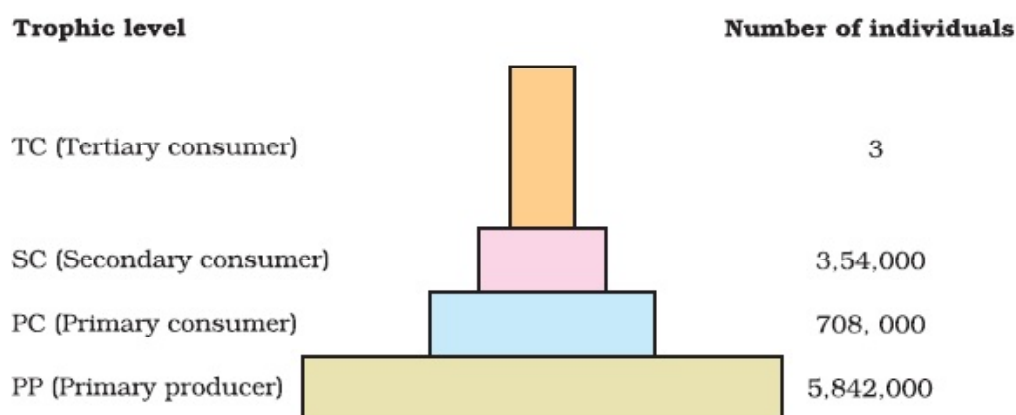
- **In a cropland ecosystem :** In croplands the crops are more in numbers. The grasshoppers feeding on crop plants are lesser in number. The frogs feeding on grasshopper are still lesser in number. The snakes feeding in frogs are fewer in number.  
Crop → Grasshopper → Frogs → Snakes → Hawks
- **In a grassland ecosystem :** In a grassland the grasses are there in large numbers. The consumers decrease in the following order.  
Grass → Grasshopper → Lizard → Hawk  
Grass → Rabbit → Fox → Lion
- **In a pond ecosystem :** The number in a pond ecosystem decreases in the following order.  
Phytoplankton → Zooplankton → Fishes → Snakes
- The pyramid of number of a single tree is **spindle-shaped**.
- Sometimes the pyramid of number is **inverted** in parasitic food chain.

### **Pyramid of Biomass**

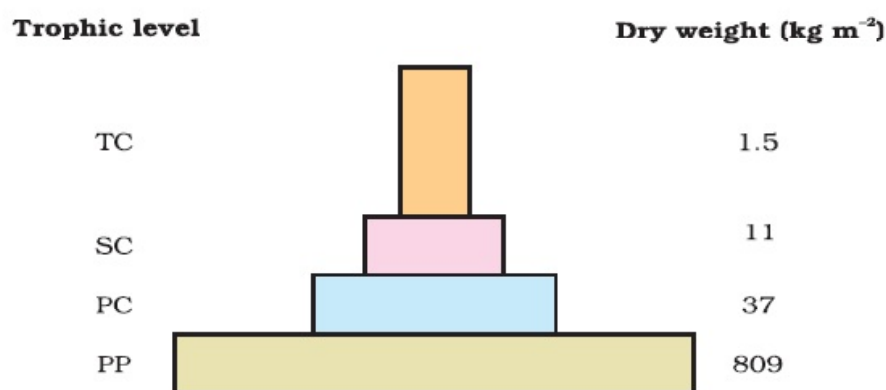
- Biomass refers to the total weight of living matter per unit area. In an ecosystem the biomass decreases from the producer level to the consumer level.
- Pyramid of biomass of terrestrial ecosystem is **upright** because at each successive trophic level the biomass tends to decrease, starting from primary producers and ending in top consumers.
- Pyramid of biomass of **aquatic ecosystem is inverted**.
- **In a grassland :** in a grassland the biomass of grasses is the maximum, and it gradually decreases towards the consumer level in the following order.  
Grass → Mouse → Snake → Hawk  
Grass → Grasshopper → Lizard → Hawk
- **In a forest :** In a forest the biomass of trees is the maximum and the biomass of the top consumer is the minimum. The decrease in weight occurs in the following order :  
Plants → Deer → Fox → Tiger  
Plants → Rabbit → Fox → Lion

### **Pyramid of Energy**

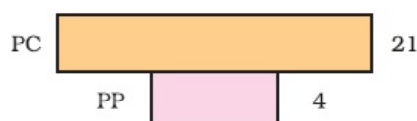
- The energy flow in an ecosystem is from the producer level to the consumer level. At each trophic level 80 to 90% of energy is lost. Hence, the amount of energy decreases from the producer level to the consumer level.
- Pyramid of energy is always **upright** because during the flow of energy from one trophic level to the next one, there always occurs a loss of energy.
- **10 percent Law :** Only 10% of the total energy stored in a trophic level is transferred to the next trophic level of a food chain. This law was given by Lindemann (1942).



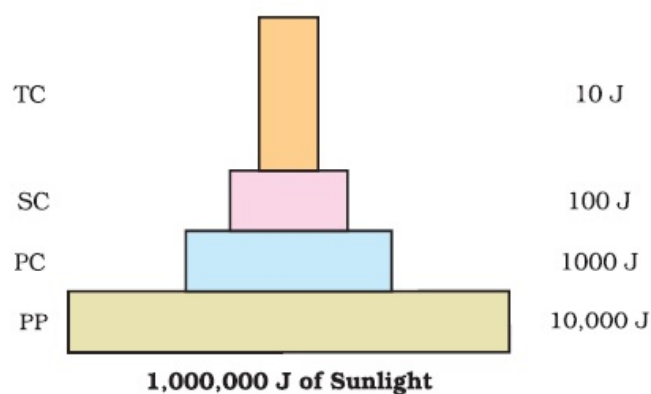
**Fig. :** Pyramid of numbers in a grassland ecosystem. Only three top-carnivores are supported in an ecosystem based on production of nearly 6 millions plants.



**Fig. :** Pyramid of biomass shows a sharp decrease in biomass at higher trophic levels



**Fig. :** Inverted pyramid of biomass-small standing crop of phytoplankton supports large



**Fig. :** An ideal pyramid of energy. Observe that primary producers convert only 1% of the energy in the sunlight available to them into NPP

- **In a grassland :** in a grassland green plants trap the maximum light energy. The energy gradually decreases towards the top consumer level.

Grass → Grasshopper → Lizard → Hawk

Grass → Rabbit → Fox → Lion

Grass → Mouse → Snake → Hawk

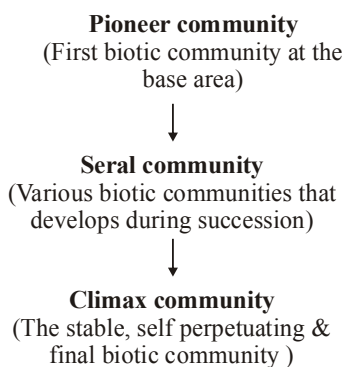
- **In a pond :** In a pond maximum energy is trapped by the phytoplankton. Then the amount of energy decreases towards the top-consumer level.

Phytoplankton → Zooplankton → Fish → Snake

Phytoplankton → Zooplankton → Small fish → large fish

## ECOLOGICAL SUCCESSION

- Ecological succession is the successive development of different biotic communities at the same site. The communities develop one after another till the development of a community which is near equilibrium with the environmental conditions. This is called **climax community**.
- Climax community is the stable perpetuating and final biotic community that develops at the end of biotic succession. It has maximum diversity & niche specialization.
- The first biotic community which invades a base area is called **pioneer community**. It is characterized by high growth rate and short life span.
- The transitional communities which develop during the ecological succession or in between the pioneer and climax community are called **seral communities**.



- The entire series of communities that is characteristic of given site is called a **sere**.

### Difference between Pioneer community and Climax community

S.No.	Pioneer community	Climax community
1	It is the first biotic community which develops in bare area.	It is the final biotic community that develops in an area.
2	It is established over a previously bare area.	It occurs over an area previously occupied by several communities.
3	It consists of fewer small sized organisms.	It consists of numerous large and small sized organisms.
4	The area is hostile for pioneer community.	The area is favourable for the climax community.
5	Life span is short.	Life span is long.
6	Growth is fast.	Growth is slow.
7	It is soon replaced by the next seral community.	It is stable. It is not replaced by any other community.

- A sequence of seres is characterized not only by the change in the set of population present, but also by a progressive increase in the diversity of species and the total quantity of living mass. The sequence of seres for a given region is often fully predictable, both with respect to the general types of population expected at each sere and to seral duration.

### Characteristics of Ecological Succession

- Formation of soil, increase in thickness and differentiation of soil.
- Increase in humus content of soil.
- Increase in biomass.
- From small lived plants to long lived plants.
- From unstable biotic community to stable biotic community.
- From lesser species diversity to higher species diversity.
- Increased niche specialization.
- Development of stratification.
- Succession occurs in both animals and plants communities side by side.
- From simple food chains to complex food chains and formation of food webs.
- From aquatic or acid environment to mesic environment.

### Types of Succession

- Succession is of **two types** : Primary and Secondary
- **Primary succession** : It is the ecological succession occurring in an area where no organisms are found, like bare rocks.
- **Secondary Succession** : This type of succession takes place in those areas where all the previous biotic communities have been destroyed, e.g. - burned forests flooded fields.

**Table : Difference between primary succession and secondary succession**

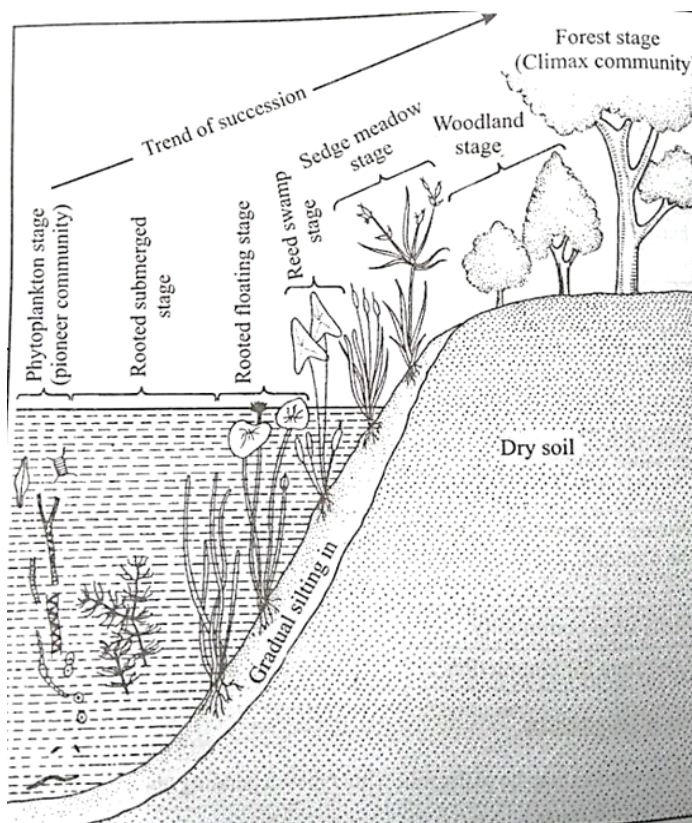
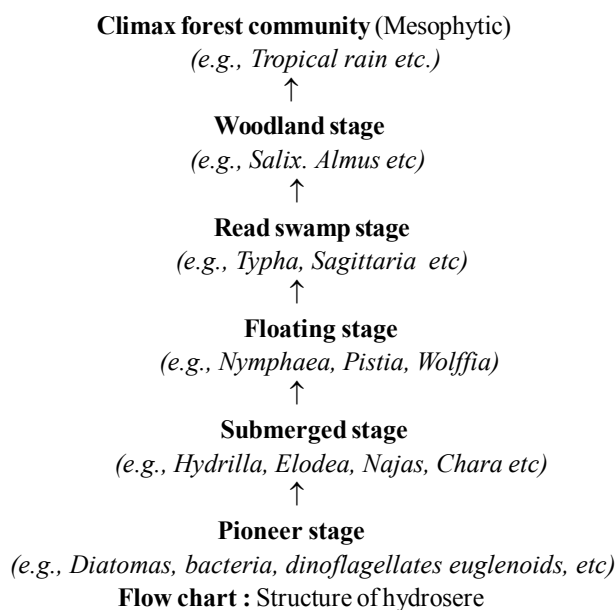
S.No.	Primary succession	Secondary Succession
1	It occurs in an area which has been bare from the beginning.	Secondary succession occurs in an area which has been denuded recently.
2	Soil is absent at the time of beginning of this succession.	Soil is present.
3	No humus in the beginning.	Humus is present before the very beginning.
4	Reproductive structure of any previous community are absent.	Reproductive structure of the previous occupants are present in the area.
5	Pioneer community comes from the outside.	Pioneer community develops partly from the previous occupants and partly from the migrants.
6	Many seral community.	Few seral community.
7	Long time for completion.	Less time for completion.

### Succession in plants

- Ecological succession may be of the following types depending upon the climatic conditions of the area where it starts.
- Successions are variously designated as **xerosere/lithosere** (succession **on bare rock**), **hydrosere** (succession in **water**), **psammosere** (succession **on sand**).

## Hydrach/Hydrosere Succession

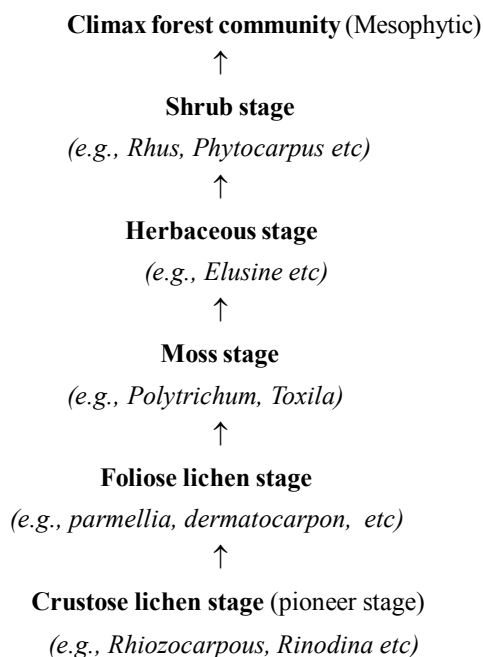
- Hydrosere is a sequence of communities that reflects the development stages in a plant succession, which commences on soil, submerged by fresh water.
- Hydrach succession** takes place in wetter areas like ponds, lakes etc. and the successional series progress from hydric to the mesic conditions.



**Fig. :** Diagram showing different plant communities appearing at different stages of a hydrosere originating in a pond

## Xerarch Succession

- Xerarch succession starts in dry areas & the series progress from xeric to mesic conditions.
- Stages in xerarch occurring on bare rock is called **lithosere**.
- Pioneer of this succession depends on climate. In tropical areas the pioneers are cyanobacteria or blue green algae. In temperate areas, they are crustose lichens.



**Flow chart :** The Structure of lithosere/xerosere

- The ecological succession on bars rocks includes the development of following communities –  
Crustose lichens → foliose lichens → mosses → grasses → shrubs → trees

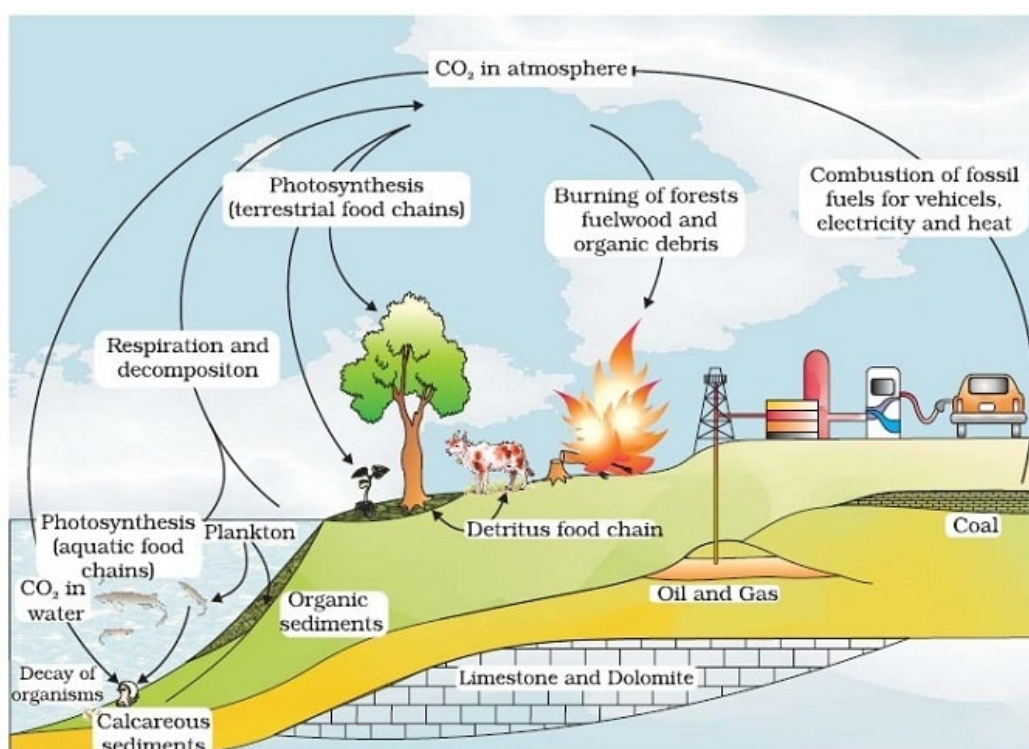
## NUTRIENT CYCLING

- These are the cyclic events by which various nutrients which are essential for the living organisms are transferred from one form to another. During these cycles, the nutrients pass from the biotic components to the abiotic components and vice-versa, hence these are also called **biogeochemical cycles**.
- **Two types** of nutrient cycles are –
  - Gaseous cycles** (nitrogen, oxygen, carbon cycles)
  - Sedimentary cycles** (phosphorus, sulphur cycles)
- In gaseous cycle, the main reservoirs of chemicals are the atmosphere and ocean.
- In sedimentary cycles, the main reservoirs are soils and rocks.

## Carbon Cycle

- Carbon is present in carbohydrates, proteins and fats.
- Carbon is taken up by plants as  $\text{CO}_2$  for photosynthesis.
- Carbon is present as  $\text{CO}_2$  in atmosphere, as graphite and carbonates in rocks and also in fossil fuels (coal, petroleum).
- Ocean are big reservoirs of carbon.

- Carbon is released as  $\text{CO}_2$  in atmosphere during
  - respiration of plants and animals
  - burning of fossil fuels
- Carbon is also released in atmosphere as methane by rice fields and marshes.
- **Carbon cycle** is **cyclic representation of carbon** assimilation by green plants (photosynthesis) which then passes into bodies of animals (plants are eaten) and finally during respiration of plants & animals & decompositions by microbes, the carbon dioxide is returned back to the atmosphere. Thus, carbon is cycled through transfer and transformation between biotic and abiotic components.

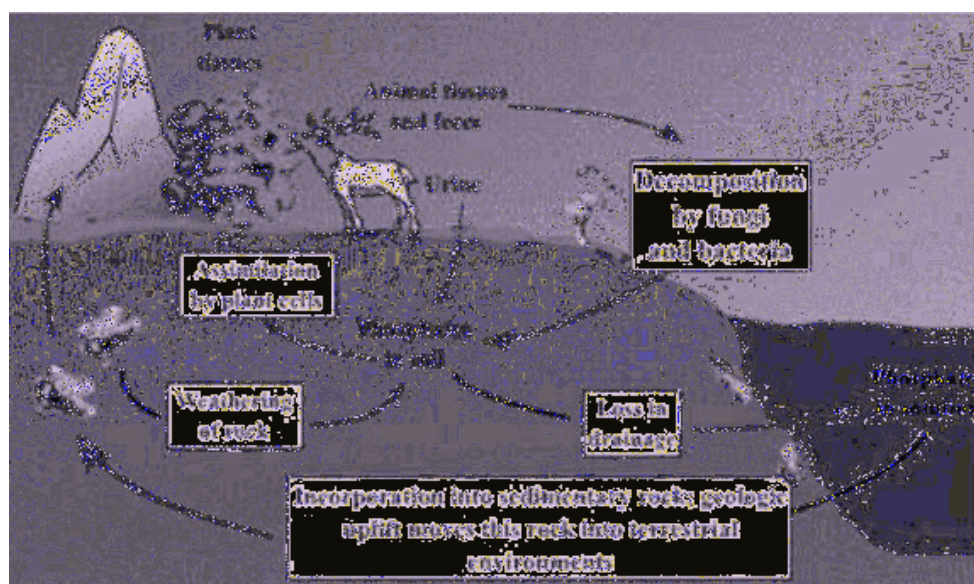


**Fig. :** Simplified model of carbon cycle in the biosphere

### Phosphorus Cycle

- Phosphorus is an important element for living beings.
- The cycling of phosphorus between biotic & abiotic components of the environment represent phosphorus cycle.
- Phosphorus is present in
  - biomembranes (as phospholipids)
  - nucleic acids (as phosphoric acid)
  - nucleotides (as AMP, ADP, ATP etc.)
  - bones and teeth (as hydroxyapatite).
- Consumers obtain phosphorus directly or indirectly from plants.
- Phosphorus is also present in phosphatic rocks.
- Phosphorus is released during the decomposition of plant and animal remains.

- The released phosphorus may reach the deeper layers of soil and gets deposited as phosphate rocks.
- Phosphorus containing rocks are mined for manufacture of fertilizers, which provide an additional supply of an organic phosphates to the abiotic environment.



**Fig. : Phosphorus cycle**

- All plants and animals eventually die and in due time, their organic remains or debris decay through the action of micro-organism and the phosphate are release into the water for recycling.

### ECOSYSTEM SERVICES

- Human beings benefit from a multitude of resources and processes that are supplied by natural ecosystem. Collectively, these benefits are known as **ecosystem services**, for example, healthy forest ecosystems purify air and water, migrate droughts and floods, cycle nutrients, generate fertile soils, provide wildlife habitat, maintain biodiversity, pollinate crops, provide storage site for carbon and also provide aesthetic, cultural and spiritual values.
- Services can be subdivided into **5 categories** –
  - (i) **Provisioning** : Such as the production of food and water.
  - (ii) **Regulating** : Such as the control of climate and disease.
  - (iii) **Supporting** : Such as nutrients cycle and crop pollination.
  - (iv) **Cultural** : Such as spiritual and recreational benefits, and
  - (v) **Preserving** : Which includes guarding against uncertainty through the maintenance of diversity.

### IMPORTANCE OF ECOSYSTEM

- **Energy** : Study of ecosystem provides information about amount of energy flowing into them, its harvesting ability and availability at various levels.
- **Biogeochemical cycling** : Density of ecosystem is governed by degree of biogeochemical cycling and the amount of inorganic nutrients entering the ecosystem from outside.
- **Food webs** : Each ecosystem has a number of food webs. The knowledge of food webs is helpful to restore a degrade ecosystem and prevent unscientific exploitation of different ecosystems.

- **Protection :** Each ecosystem whether natural or man made requires protection from pollutants and pests.
- **Inter-relationships :** Study of ecosystems gives information about inter-relationships amongst various types of organisms as well as between organisms and their abiotic environment.
- **Carrying capacity :** By knowing the carrying capacity of ecosystem, it can be known as to what is the number of products and consumers which can be supported by that ecosystem.
- **Inputs :** The shortage on inputs can be known and corrected.